GEOLOGIC CHARACTERIZATION OF COWPEN LAKE

PUTNAM COUNTY, FLORIDA

By

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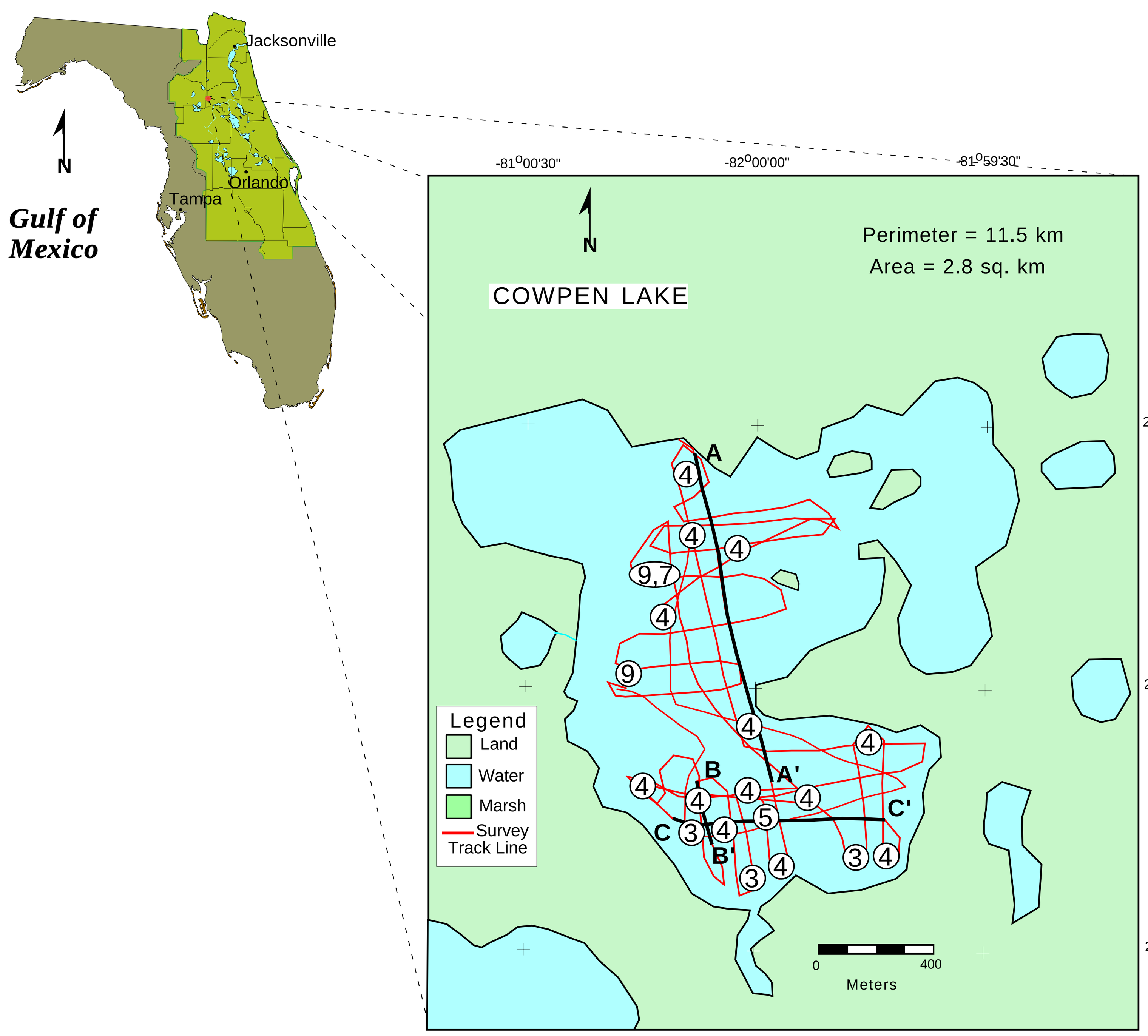
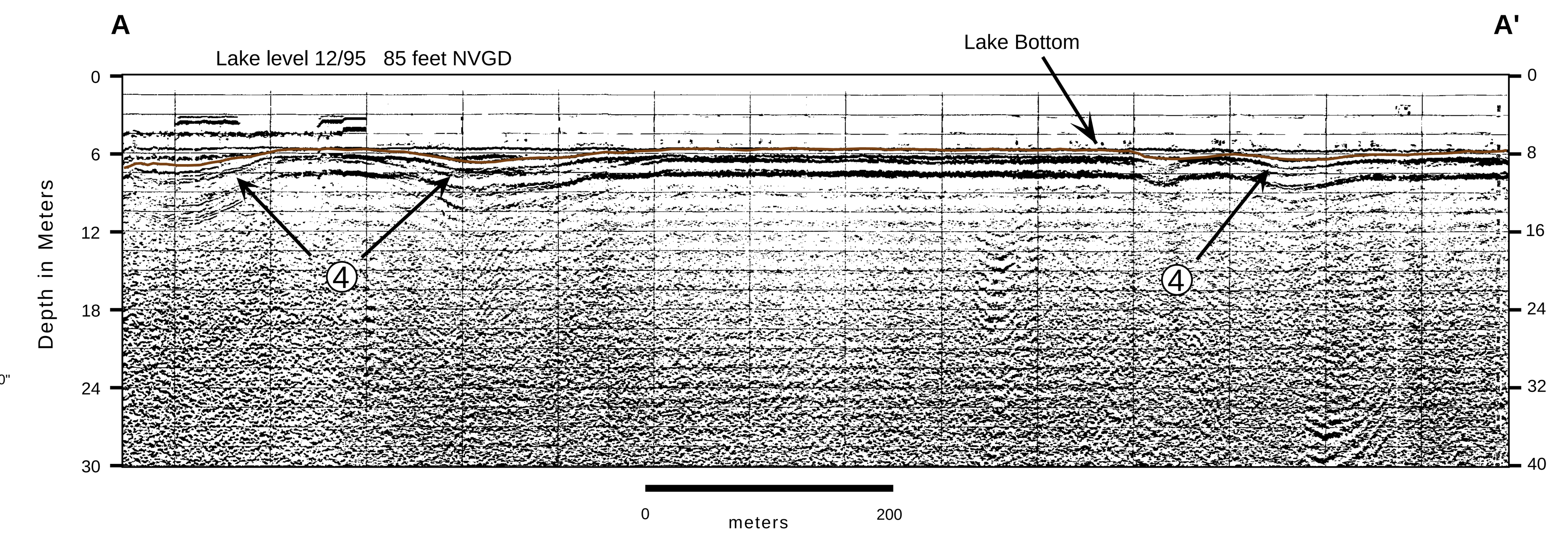
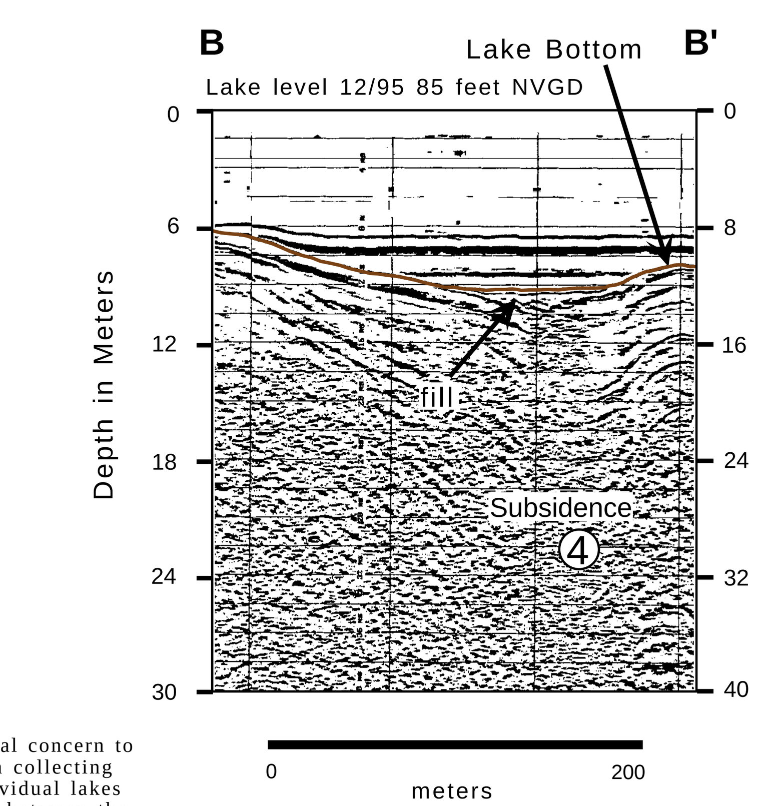
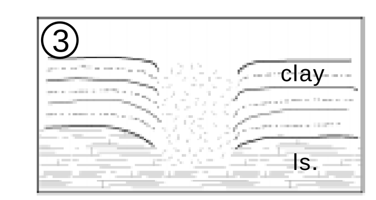


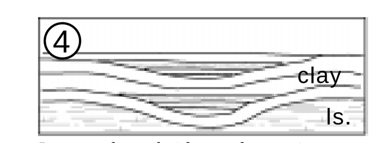




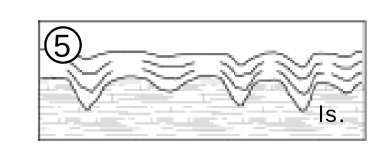
EXPLANATION



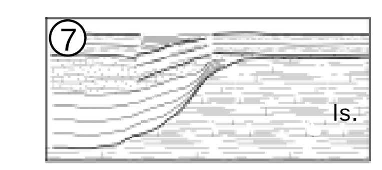
Horizontal reflectors continuous on either side of a central non-reflective zone. Horizontal layers bend downward towards the central zone. These features are representative of filled collapse sinks. The size may range from tens of meters to kilometers across a lake basin.



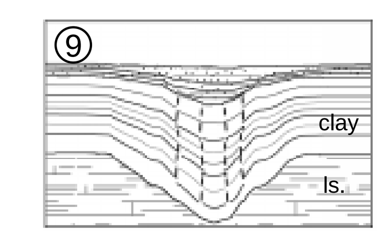
Low angle, subsidence depressions. Parallel reflectors are relatively intact. Horizontal reflectors onlap onto the subsided parallel reflectors and represent deposition during subsidence. These can be large basin size features or tens of feet.



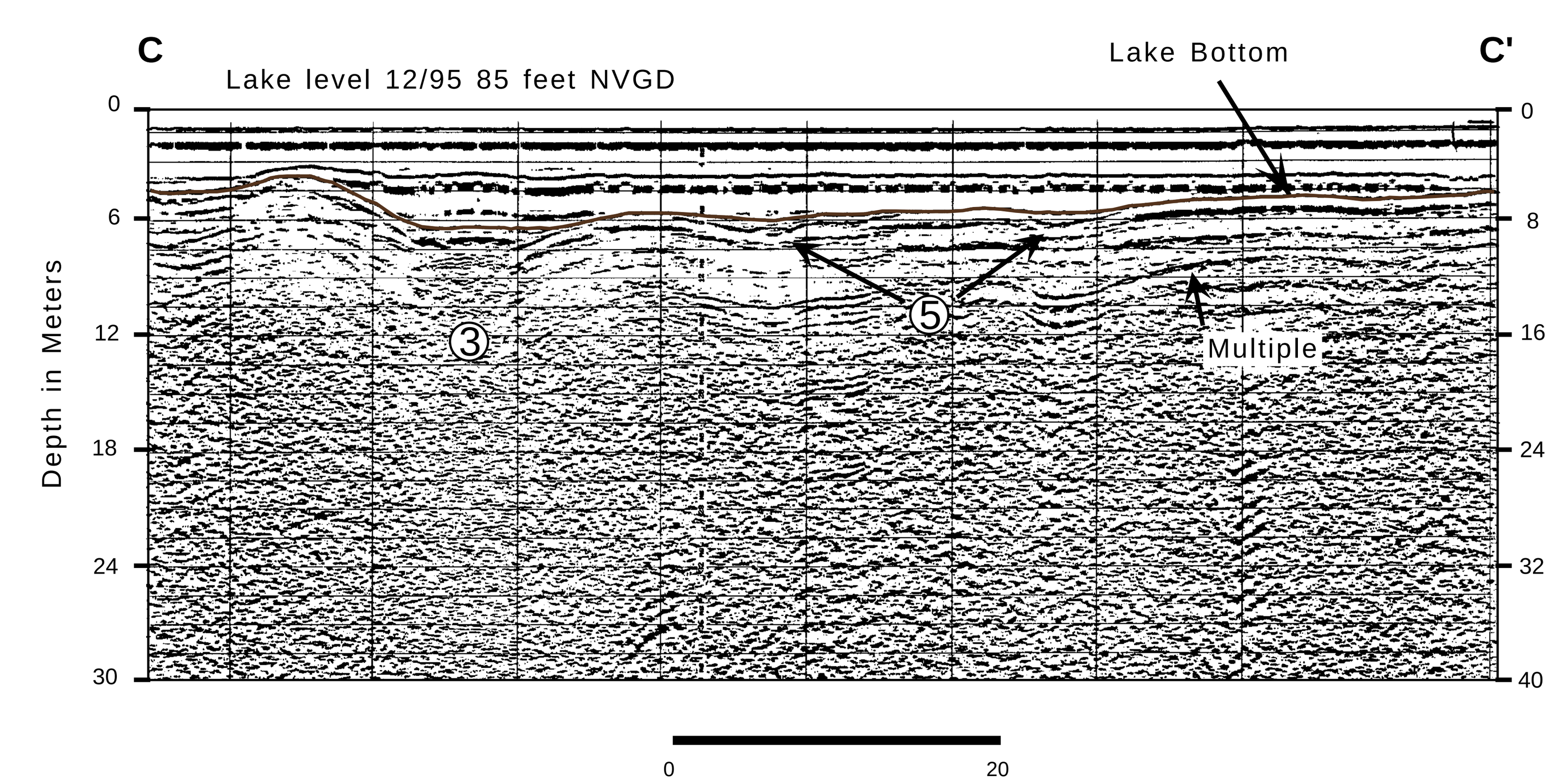
Numerous small features with high angle reflectors dipping toward their center. These features may represent localized collapse sinks or filled solution pipes.



Mid- to high-angle parallel reflectors with indications of vertical displacement and rotation. Feature may be buried by overburden. Represents blocks from the sides of collapse sinks that have slumped into the sink.



Low- to mid-angle subsidence depressions. Parallel reflectors have undergone displacement and rotation, creating stress fractures and faulting within the depression. The subsidence may or may not be filled with overburden.



INTRODUCTION

The potential fliud exchange between lakes of northern Florida and the Floridan aquifer and the process by which exchange occurs is of critical concern to the St. Johns River Water Management District (SJRWMD). High-resolution seismic tools with relatively new digital technology were utilized in collecting geophysical data from > 40 lakes and rivers. The data collected shows the application of these techniques in understanding the formation of individual lakes and rivers, thus aiding in the management of these natural resources by identifying breaches or areas where the confining units are thin or absent between the water bodies, the Intermediate aquifer and the Floridian aquifer.

This study was a cooperative investigation conducted from 1993 to 1996 by the SJRWMD and U.S. Geological Survey Center for Coastal Geology (USGS). Since 1989 there have been technical and hardware advances in the digital acquisition of high-resolution seismic data. The primary objective of this cooperative was to test newly developed digital high-resolution single-channel marine seismic continuous-profiling-equipment (HRSP) and apply this technology to identify subbottom features that may enhance leakage from selected lakes and the St. Johns River. The target features include: (1) identifying evidence of breaches or discontinuities in the confining units between the water bodies and the aquifer, and; (2) identifying areas where the confining unit is thin or absent.

METHODS

In cooperation with SJRWMD the USGS acquired and upgraded a digital seismic acquisition system. The Elics Delph2 High-Resolution Seismic System was acquired with proprietary hardware and software running in real time on an Industrial Computer Corp. 486/33 PC. Hard-copy data was displayed on a gray scale thermal plotter. Digital data was stored on a rewritable Magneto-Optical compact disk. Navigation data was collected using a Trimble GPS or PLGR (Rockwell) GPS. GeoLink XDS mapping software was used to display navigation.

The acoustic source was the Huntec Model 4425 Seismic Source Module and a catamaran sled with an electromechanical device. Occasionally, an ORE Geopulse power supply was substituted for the Huntec Model 4425. Power was set at 60 joules or 135 joules depending upon conditions. An Innovative Transducers Inc. ST-5 multi-element hydrophone was used to detect the return acoustical pulse. This pulse was fed directly into the Elics Delph2 system for storage and processing.

Forty-four line-km of HRSP data was collected from Lake Disston. A velocity of 1500 meters per second (m/s) was used to calculate a depth scale for the seismic profiles. Measured site specific velocity data is not available for these sites.

These surveys were conducted in part to test the effectiveness of shallow-water marine geophysical techniques in the freshwater lakes of central Florida. Acquisition techniques were similar but modifications were necessary. Data quality varied from good to poor with different areas and varying conditions. As acquisition techniques improved so did data quality in general. In many areas an acoustic multiple masked much of the shallow geologic data.

Physiography

Cowpen Lake is located in western Putnam County, Florida. The lake is located within the Interlachen Sand Hills of the Central Lakes District. The area around the lake is dominated by many small lakes and marshland, particularly Levys Prairie to the north. Lake level in March of 1995 was 26 m (85 ft) NVGD. Cowpen's shoreline is very irregular, with a perimeter of 22 km and a surface area of 29.5 sq km.

GEOLOGIC CHARACTERIZATION

The acoustic signal in Cowpen Lake as a whole is relatively weak. This is shown in the example profiles shown at right (A-A', B-B' and C-C'). Factors which contribute to a noisy or weak acoutical return in the lakes of this study area include proximity of hardbottom (limestone) to the sediment surface, accumulation of organic debris on the lake bottom, shallow water depths and proximity, steepness and irregularity of the shoreline. In Cowpen Lake, the nearby and irregular shoreline could create interference (noise) in the signal, and the marshy area in which it resides could produce organic-rich surficial sediments which dampen the return. As a result, little can be seen in the seismic profiles below about 10-12 meters. The top of the Ocala Formation is estimated to be around 20-30 meters below lake level (~0 feet NVGD), but is obscured in the profiles. The lake bottom shows an undulating surface marked by localized subsidences less than tens of meters in width. Profile A-A' and B-B' show an accumulation of material within these depressions (karst feature Type 4, see explanation). This material may mask any return from below, as shown in example C-C' (karst feature Type 3). Although penetration does not extend much below the sediment surface, it appears that that lake is not experiencing any dramatic subsurface collapse, Instead small, localized depressions indicate minor dissolutions such as solution fractures in the underlying limestone.